REMARKS

The invention is a method for maintaining accuracy of a clock which keeps clock time, a clock for use in a radio communications device which keeps clock time, and a radio communication device which keeps clock time.

The invention contains numerous novel features which are not taught in the prior art which include that clock time, as set on a first occasion, is stored and that adjusting of a time keeping operation of the clock is on a basis of a difference between stored clock time as set on the first occasion and the clock time just prior to the second occasion; intelligence is provided that detects whether adjustments to the time keeping operation of the clock should be made or not as, for example, based upon whether a battery is remove; re-tuning of an oscillator which is useful when the clock forms part of a radio device having a baseband and a radio interface and the oscillator is used to provide a time base to the baseband; the clock is part of a radio device and the clock time is set by a remote time reference via a radio interface of the radio device and the time keeping operation of the clock is adjusted based on predictive models of behavior of components of the clock.

Claims 1-5 and 13 stand rejected under 35 U.S.C. §102 as being anticipated by United States Patent 4,407,589 (Davidson et al). This ground of rejection is traversed for the following reasons.

The Examiner, with respect to claim 1, reasons as follows:

> As per claim 1, Davidson teaches a method for maintaining an accuracy of a clock [col. 5, lines 66-67], comprising the steps of:
> setting a clock time on a first occasion [col. 5, lines 20-21];
> setting the clock time of on a second occasion [col. 5, lines 31-32]; and

adjusting a time-keeping operation of the clock on a basis of a time which elapsed between the first and second occasions, and a difference in clock time just prior to the second occasion and as set on the second occasion [col. 5, lines 2-9, 29-40].

Claim 27 corresponds to claim 1 except that the preamble has been amended to recite that the clock keeps clock time and revisions have been made to recite proper antecedent basis therein.

Claim 27 recites "a method for maintaining accuracy of a clock which keeps clock time comprising the steps of: setting the clock time on a first occasion; setting the clock time on a second occasion; and adjusting a time-keeping operation of the clock on a basis of time which elapsed between the first and second occasions, and a difference in the clock time just prior to the second occasion and on the second occasion. The Examiner reasons that the adjusting step of claim 1, which corresponds to the adjusting step of claim 27, is disclosed in column 5, lines 2-9 and 28-40 of Davidson et al. The Examiner is mistaken in this conclusion.

What is described in the second embodiment of Davidson et al, which description begins at the bottom of column 4, and pertains to Fig. 2, is an operation which is different than that as claimed. The difference is that Davidson et al adjusts the time keeping operation of the clock on a basis of time which elapsed between a first occasion and a second occasion and a difference in the clock time at the second occasion and a pre-stored expected time value. Therefore, Davidson et al do not disclose the adjusting step as recited in claim 27, including "a difference in the clock time just prior to the second occasion and as set on the second occasion" since clock time is the

time the clock keeps as recited in the preamble and as referred to in the body of claim 27. The display register 33 is set to a future time at which a time signal will mark the occurrence of the future time stored therein and therefore, is not actual clock time. Moreover, when the time standard is heard the reset 40 is operated causing the time in the display register which is not clock time kept by Davidson et al's clock to produce the error E which is the error accumulated by the timepiece during the time T.

Moreover, there is no basis why a person of ordinary skill in the art would be led to modify the teachings of Davidson et al to arrive at the subject matter of claim 27.

Moreover, dependent claim 29 further limits the method of claim 27 in reciting that the time keeping operation of the clock is adjusted by re-tuning a frequency of an oscillator. Claim 29 corresponds to claim 3. The Examiner has cited column 3, lines 22-29, of Davidson et al as meeting this subject matter. However, the aforementioned portion of Davidson et al discusses an adjustment value being inserted into a frequency divider 12 which does not correspond to the claimed re-tuning of a frequency of an oscillator.

Newly submitted claim 30 limits claim 29 in reciting that the clock forms part of a radio device including a baseband and a radio interface and the oscillator is used to provide a time base to the baseband. It is noted that in the rejection of claims 6-12 and 14-26 that the Examiner cited United States Patent 5,528,560 (Ogiyama) for clock time being sent by a remote time reference via a radio interface of a radio device. This disclosure does not meet the subject matter of claim 30.

Claim 33 limits claim 27 in reciting that the clock forms part of a radio device and the clock time is set by a remote time reference via a radio interface of the radio device. This subject matter corresponds to claim 6 which was rejected, as discussed above, as being obvious over Davidson et al in view of Ogiyama. Ogiyama does not cure the deficiencies noted above with respect to Davidson et al regarding the subject matter of claim 33.

Claim 34, which corresponds to claim 7, recites a clock for use in a radio communications device which keeps clock time comprising time resetting means for re-setting the clock on a first occasion to a first clock time and on a second occasion, to a second clock time; and adjustment means, responsive to re-setting the clock on the second occasion to adjust a time-keeping operation of the clock on a basis of time which elapsed between the first and second occasions and a difference in the clock time just prior to the second occasion and as set on the second occasion. Claim 34 is patentable for the same reasons set forth above with respect to claim 27 regarding Davidson et al.

Claim 35 further limits claim 34 in reciting an oscillator and processing means to process the signal from the oscillator on a basis of a timing parameter to produce an indication of the clock time. Claim 35 is patentable for the same reasons set forth above with respect to claim 34.

Claim 36 further limits claim 34 in reciting the adjustment means includes means for re-tuning the oscillator. As stated above, Davidson et al do not disclose the re-tuning of an oscillator and it would not be obvious to a

person of ordinary skill in the art to re-turn an oscillator in Davidson et al to arrive at the subject matter of claim 36.

Claim 38 further limits claim 34 in reciting means to adjust the time keeping operation of the clock based on predictive models of behavior of the components of the clock. Claim 38 corresponds to claim 11. It is noted that the Examiner has not discussed the subject matter of claim 11 in the Office Action. While the Examiner refers to the rejection of claims 1-6, it should be noted that those claims do not recite anything pertaining to adjusting of a time keeping operation on predictive models of behavior of the components of the clock. It is submitted that the subject matter of claim 38 is patentable over the combination of Davidson et al and Ogiyama since neither of these references disclose the aforementioned subject matter.

Claims 40 and 45 are patentable for the same reasons set forth above with respect to claim 29.

Claims 47-49 are patentable for the same reasons set forth above with respect to 38.

Claim 54 recites a method for maintaining accuracy of a clock which keeps clock time comprising the steps of: setting the clock on a first occasion; storing the clock time as set on the first occasion; setting the clock on a second occasion; and adjusting a time-keeping operation of the clock on a basis of a difference between a stored clock time as set on the first occasion and the clock time just prior to the second occasion, and a difference between the clock time just prior to the second occasion and as set on the second occasion. Claim 54 is patentable for the same reasons set forth

above with respect to claim 27 regarding the differences discussed pertaining to Davidson et al.

Claims 55 and 56 respectively recite a method for maintaining accuracy of a clock which keeps clock time and a clock suitable for use in a radio communications device which includes "detecting whether adjustment of a time-keeping operation of the clock would be erroneous and if not erroneous, adjusting a time-keeping operation of the clock on a basis of the time which elapsed between the first and second occasions and a difference in the clock time just prior to the second occasion and as set on the second occasion" as recited in claim 55 and "detection means for detecting whether adjustment of a time-keeping operation of the clock would be erroneous and if erroneous, preventing adjustment of the time-keeping operation of the clock" as recited in claim 56. Davidson et al do not detect anything pertaining to whether adjustment of a time-keeping operation of the clock would be erroneous and if not erroneous, resetting the clock as recited in claim 55. Claim 55 is patentable for the reasons that Davidson et al do not detect whether an adjustment of a time-keeping operation of the clock would be erroneous and furthermore, does not adjust the time-keeping operation for the reasons set forth above as discussed pertaining to claim 27 and with respect to claim 56 do not disclose anything which, if the erroneous condition of adjustment of a time-keeping operation of the clock was detected, prevents adjustment of a time-keeping operation of the clock.

Independent claims 57 and 58 recite a radio communications device which keeps clock time. Each claim recites a clock, including a tunable

oscillator for providing a time base to the baseband, and further, re-tuning an oscillator on a basis of time which elapse between first and second occasions and a difference in the clock time just prior to the second occasion and as set on the second occasion. Davidson et al do not disclose a tunable oscillator which is re-tuned and furthermore, does not disclose the aforementioned adjustment for the reasons set forth in the discussion of claim 27.

Claim 59 recites a clock for use in a radio communications device which keeps clock time. Claim 59 recites adjustment means which resets the clock on a basis of time which elapsed between the first and second occasions and a difference in the clock time just prior to the second occasion and as set on a second occasion which is not found in Davidson et al for the reasons set forth above with respect to claim 27 and further, the adjustment means adjusts the time-keeping operation of the clock based on predictive models of behavior of components of the clock which is patentable for the reasons set forth above with respect to claims 38 and 47-49.

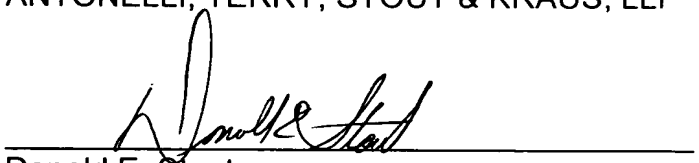
In view of the foregoing amendments and remarks, it is submitted that each of the claims in the application is in condition for allowance. Accordingly, early allowance thereof is respectfully requested.

To the extent necessary, Applicants petition for an extension of time under 37 C.F.R. §1.136. Please charge any shortage in fees due in connection with the

filing of this paper, including extension of time fees, to Deposit Account No. 01-2135 (1156.43039TRN) and please credit any excess fees to such Deposit Account.

Respectfully submitted,

ANTONELLI, TERRY, STOUT & KRAUS, LLP



Donald E. Stout
Registration No. 26,422
(703) 312-6600

Attachments
DES:dlh

#1 (CNOE)
4-6-04

1156.43039TRN
PH 8533 US - NC 33424 US

SECOND SUBSTITUTE SPECIFICATION

A CLOCK

~~Background of the Invention~~

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to maintaining the accuracy of a clock, and is especially, but not exclusively applicable to clocks within portable radio communication devices, such as radiotelephones.

Description of the Prior Art

[0002] It is well known for a radiotelephone to include time-keeping circuitry which enables it to serve additionally as a clock for the user. Often, the clock is driven from a crystal oscillator the output signal of which is also used as timing base for the other functions which the radiotelephone performs. Sometimes, a dedicated oscillator is provided to drive the clock. In either case, the stability of the output frequency of the oscillator has a great impact on the accuracy of the clock.

[0003] Many techniques are known to maintain the stability of the output frequency of the oscillator in the face of influences, such as temperature variation, ~~ageing~~ aging and the like, which tend to cause the output frequency to drift from its initial value. These known techniques generally increase the cost of the oscillator by, for example, using a more expensive and inherently more robust crystal and/or adding additional circuitry which attempts to compensate for the drift causing influences.

~~Summary of the Invention~~

SUMMARY OF THE INVENTION

[0004] With this background in mind, according to one aspect, the present invention may provide a method for maintaining the accuracy of a clock, comprising the steps of: setting the clock time on a first occasion; setting the clock time of on a second occasion; and adjusting the time-keeping operation of the clock on the basis of the time which elapsed between the first and second occasions, and the difference in clock time just prior to the second occasion and as set on the second occasion.

[0005] In this way, the accuracy of the clock can be maintained within reasonable bounds in the face of drift-causing influences, not by increasing the cost or

complexity of the clock circuitry itself to arrive at the required accuracy, but by using feedback from an external, more accurate source to adjust the time-keeping operation of the clock to compensate for the drift-causing influences.

[0006] Preferably, the clock comprises an oscillator and processing means for processing the signal from the oscillator on the basis of a timing parameter to produce an indication of clock time.

[0007] In one embodiment, the time-keeping operation of the clock may be adjusted by directly re-tuning the crystal of the oscillator. Alternatively or additionally, the timing parameter of the processing means may be adjusted.

[0008] The clock time may be set manually by the user. Alternatively, where the clock is implemented as part of a radio communication device, it can be automatically reset from time to time from an accurate remote source via the radio interface.

[0009] In other embodiments, the clock cannot only passively adjust its time-keeping operations to adjust to past conditions, but can also be based on predictive models of the ~~behaviour~~ behavior of the oscillator in different environments temperature-wise, the ~~behaviour~~ behavior of the oscillator as it ages and the like, the clock can also seek to

pre-compensate for frequency drift before or as it is happening.

[0010] According to a further aspect of the invention, the present invention may provide a clock comprising time-setting means to set the clock time; and adjustment means for adjusting the time-keeping operation of the clock when the clock time is reset.

[0011] Preferably, the clock comprises an oscillator and processing means to process the signal from the oscillator on the basis of a timing parameter to produce an indication of clock time.

[0012] In one embodiment, the adjustment means includes means for re-tuning the oscillator. Alternatively or additionally, the adjustment means is operable to adjust the timing parameter.

[0013] According to a further aspect of the invention, the present invention may provide a radio communication device including a clock as previously discussed.

~~Brief Description of the Drawings~~

BRIEF DESCRPTION OF THE DRAWINGS

[0014] Exemplary embodiments of the invention are hereindescribed with reference to the accompanying drawings, in which:

[0015] Figures 1 (a) and 1 (b) show schematic hardware layouts for first and second embodiments of the invention, respectively;

[0016] Figure 2 is a time line illustrating the present invention; and

[0017] Figure 3 is a view of an embodiment of Figure 1 communicating with a base station and the internet.

~~Detailed Description of the Invention~~

DETAILED DESCRIPTION OF THE INVENTION

[0018] Referring to Figure 1 (a), a cellular radiotelephone 1 in accordance with a first embodiment of the present invention is shown. The radiotelephone comprises a baseband unit 10 for controlling the general operation of the radiotelephone. The baseband unit 10 is also coupled to a display 14, a radio interface 16 by which the telephone can communicate over the air with a base station~~,~~ and a key pad 18. The timing base for the baseband unit 10 is provided by a crystal oscillator 30. Also, a clock unit 40 also supplies clock time data to the baseband unit 10 which, depending on the mode in which the radiotelephone is being used, can be displayed on the display 14. The clock unit 40 includes a dedicated crystal oscillator 42 which produces an output signal at a nominal frequency f after it has been tuned during manufacture. The clock unit 40

also comprises a processing unit 44 which keeps time in clock time format, i.e., date/hours/minutes, and counts the pulses produced by the oscillator 42 to provide an indication of the passage of time so that the clack time be appropriately updated. The processing unit 44 also includes semi-permanent memory 45. The clock time held by the processing means can be set from the user via the key pad 18. The radiotelephone is powered from a removable battery power supply 35. When the battery power is removed, the oscillator clock unit 40 continues to operate normally for a short while deriving its power from a large capacitor (not shown). Once the capacitor runs down the clock unit 40 stops operating.

[0019] As the radiotelephone leaves the manufacturing process, the nominal frequency of the oscillator is accurately known. Therefore, the processing unit 44, having a timing parameter P set equal to f, is able to count P pulses and equate that duration with one second (because P=f) and hence accurately update its clock time. So when the user initially gets the radiotelephone and sets the clock time via the key pad, the radiotelephone is able to accurately keep time. When the clock time is initially set, this time, $T_{initial}$, is stored in the semi-permanent memory 45. Timing parameter P is also stored in the semi-permanent memory 45. As time goes by, the effects of the climate in which the radiotelephone is being used, the ~~ageing~~ aging of the oscillator 42 and the like,

causes the actual output of the oscillator 42 to drift + Δf. As a result, when the processing unit 44 counts P=f pulses, this no longer equates exactly to one second and so the clock time shown by the radiotelephone incrementally diverges from the actual time.

[0020] When the user resets the time, at time T_{end}, because the user has noted that the displayed time is no longer correct, the processing unit 44 calculates (1) t_{period}, the time since the clock time was last reset, $T_{end} - T_{initial}$, and (ii) ΔT calculates the difference in clock time as the clock is reset, T_{reset}, and the clock time momentarily before the clock time is reset, T_{end}. By calculating ~~$t_{periods}$~~ t_{period}, ΔT, the processing unit 44 can then evaluate the average error per unit time over the interval T_{reset} and make a correction to the timing parameter P to reflect this error.

[0021] In this way, the processing unit 44 seeks to use the knowledge of the time-keeping error made over the interval t_{period} to adjust the time-keeping operation of the clock unit 40 to keep time more accurately in the future.

[0022] This corrective process is applied every time the user resets the clock time. From the foregoing, it will be appreciated that T_{reset} for one interval becomes $T_{initial}$ for the next interval.

[0023] In Figure 1 (b), in which similar parts have been given the same reference numbers, a radiotelephone ~~1~~ in accordance with a second embodiment of the present invention is shown. This embodiment differs from the first embodiment in that the oscillator 30 for driving the baseband unit is dispensed with and, instead, the clock oscillator 42 is used to provide the time base for baseband unit 10 also. In addition, the clock unit 40 includes an oscillator tuning unit 40.

[0024] The operation of this embodiment is the same as the first Figure 1 (a) embodiment except on the basis of the calculated values Of t_{period} and AT, the oscillator tuning unit re-tunes the output frequency of the oscillator 44.

[0025] It will be appreciated that an added advantage of this second embodiment of the invention is that the frequency output of the oscillator 42 is brought back towards its nominal value f and this is advantageous to the reliability of the operation of the rest of the radiotelephone.

[0026] In both embodiments, because the adjust of the time-keeping operation of the clock unit 40 depends on $T_{initial}$ which is stored in the memory 45, Tend and T_{reset}, it is important to try and identify situations in which the battery for a prolonged time has been removed or where the clock time entered by the user is erroneous. It will be clear that if these eventualities are not recognized then it will be

possible that the operation of the clock unit will be severely distorted and bear little resemblance to the passage of actual time. This is particularly serious in the case of the second embodiment, where the effect of the error will not be localized to the clock unit 40 itself, but also affect the operation of the other functions of the radiotelephone.

[0027] Where the battery is removed for a prolonged period, only the data in the semi-permanent memory will be retained. On powering up the radiotelephone again, the clock time will assume a zero default status. As the clock time includes a date field as well, this condition will be very easy to detect as a zero day or month does not exist normally. Where the user enters an erroneous clock time, this can be detected by setting a threshold for ΔT above which it is assumed that there has been a user error. In both these cases, the time-keeping operation of the clock unit 44 is not adjusted.

[0028] Another situation in which the time-keeping operation might not be adjusted is where t_{period} is a very short period.

[0029] In other embodiments of the invention and referring to Figure 3, the radiotelephone 1 automatically requests an accurate version of clock time from a base station 100 of a cellular network, or from the internet 1 10 which it gains access to via the base station 110. In other embodiments, the base station 100 can regularly update the radiotelephone 1

with the correct clock time which it supplies from its own accurate clock or which it requests from the internet 110.

[0030] In other embodiments, the radio telephone 1 cannot only passively adjust its time-keeping operations to adjust to past conditions, but can also based on predictive models of the ~~behaviour~~ behavior of the oscillator in different environments temperature-wise, the ~~behaviour~~ behavior of the oscillator as it ages and the like, the clock can seek to pre-compensate for frequency drift before or as it is happening.

Abstract

A method for maintaining the accuracy of a clock, comprising the steps of setting the clock time on a first occasion; setting the clock time of on a second occasion; and adjusting the time-keeping operation of the clock on the basis of the time which elapsed between the first and second occasions, and the difference in clock time just prior to the second occasion and as set on the second occasion.